Cattle identification: the history of nose prints approach in brief

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Cattle identification: the history of nose prints approach in brief

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Abstract. Petersen was the first published paper to address cattle biometrics and identification problem by suggesting a permanent cattle identification method based on nose print principles widely accepted today. His major concern was on proper identification of cattle for registration and of cattle on an official test so that the possibility of swapping, false insurance claims, and ownership disputes can be guarded against. It was with this identification problem in the mind of every breeder that the practicable suggestion of using nose print as means of identification was made by O. H. Baker of the American Jersey Cattle Club in Petersen's paper entitled "The identification of the bovine by means of nose-prints". Before the advent of the nose print method, cattle identification has been by conventional constructs such as tattoo, tags, photographs, descriptions, branding (hot and freeze), ear notching, and sketching (drawings) the color markings on them on paper for registration and identification purposes. These classical methods of identification cause trouble among the breeders especially when their cattle are sold or are on an official test due to lack of artistic ability on the part of the breeders which makes the matching of the sketches and the markings on the cattle disagree. Presented in this paper are the various cattle biometrics and identification methods, most especially from the classical methods to the modern methods.

1. Introduction

The advancement in technology has greatly evolved how animals such as cattle are identified. Classically, cattle are identified by any of the following methods namely branding, paint branding, tagging, ear notching, tattooing, radio frequency identification, nose printing, and biometrics method.

However, these identification methods are not completely robust and reliable making the need to advance the methods a necessity. Petersen [1] proposed cattle biometrics and identification solution by suggesting a permanent cattle identification method based on nose print principles widely accepted today. His principle was built upon by today's animal biometrics researchers.

2. Classical cattle identification methods

2.1. Branding

Hot iron was the earliest cattle identification method that dates back to the time of ancient Egyptians. To get hot iron branding, the branding irons undergo fire to become heated till the brands become red hot which are applied to the cattle's hide to kill the cells that grow hair follicle making permanent markings. Freeze branding is another type of branding which is similar to hot branding but different in method; instead of applying the method of iron branding, liquid nitrogen or dry ice and alcohol are employed in which the branding irons are chilled. During the application of this method to the cattle's hide, the method ensures the protection of the cells that grow the hair while the chilled iron kills the cells that color the hair. The result of this method is the growth of white or colorless hair which produces permanent brand marking [2]. Paint branding is another temporary method of identifying cattle with clear visibility. Its application resembles the method employ in hot iron and freeze branding but instead for the brands to undergo fire or any of liquid nitrogen, dry ice, and alcohol procedures, they are made to pass through a paint soaked burlap sack before firmly pressed on to the body of the cattle [2].

2.2. Tagging

Over many decades, tagging of cattle has taken different methods; according to Blancou [3] wearing collars on cattle could be traced to the Akkadian texts which were written more than five thousand years ago. Pertinent identification details could be written on the medallion and attached to collars for cattle identification. Also, earrings were used to differentiate large and small cattle in Persia [3]. There are different ways to apply tags; they can be used with neck-chain [2] or by piercing. To put tags on the cattle, ears of the cattle are pierced in-between the second and the third cartilage rib making it easy for both front and rear visual identification of the cattle. Although tags are relatively cheap and have clear readability, the process that leads to it could be injurious.

2.3. Ear notching

Ear notching is a traditionally arranged method that is common for herd identification in which cattle's identification is based on the order of their birth within the available breeding for permanent identification provided it is done correctly. Litter number (common for identifying piglet) is notched on the right ear of the cattle called the litter ear, and the cattle are notched within the litter on the left ear of the cattle called individual cattle ear. The same litter number but with different cattle numbers is assigned to cattle within the same litter.

2.4. Tattooing

Tattooing is a common and permanent method of cattle identification by impressing or imprinting the combination of indelible numbers and letters into the skin of the cattle. Cattle as ungulate animals have their tattoos placed in the ear just above the first cartilage rib to avoid ear tags interference. A tattoo is applied to cattle using tattoo tools [2] through which tattoo punctures are made on the cattle. The punctures are cleaned with alcohol, and ink is rubbed with the tattoo pressed on, and more inks are rubbed into the punctures leaving permanent and visible tattoo once the ear is healed.

2.5. Radiofrequency identification

Radio Frequency Identification (RFID) is an electronic animal identification method especially for ungulate animals like cattle. RFID is made up of a microchip with a small transmitter radio and

antenna for communicating with a reader. Different methods of application exist for RFID technology with microchip implants, ear tags, ruminal boluses, and neck collars being the most common ones. RFID ear tags have the technology embedded in the cattle's ear like a number ear tag. A Balling gun is used to administer ruminal boluses on cattle by retaining the ruminal boluses in the cattle fore-stomach [4]. Neck collars, a resemblance of neck chains use the electronic tagging method instead of a number tag [5-8]. Irrespective of any of these RFID technologies used, a scanner must read the microchip, get the radio signal interpreted as a numerical code, and generate the cattle's recorded information from the software meant for herd management [2]. RFID technology provides individual unique identification codes, it requires no line of sight visual readings, and its signal can penetrate various walls and get read by the scanner, however, it is expensive to set up and has the tendency of getting the transponders lost.

2.6. Nose printing

Nose prints are a unique, unalterable, and permanent method of identification commonly used for cattle identification. Nose prints are similar to human fingerprints in that no two nose prints of different cattle are the same when compared as there must be six identifiable matching lines or dots that differentiate them as found in human fingerprints. Advanced work on this method of identification was carried out by Petersen [1]. Headlock is mostly used to restrain the cattle whose nose is to be printed by having its nose dried and a small amount of ink placed on it, and then get the nose pressed onto an index card firmly held to copy the ink print onto the card [2]. This method of identification is painless and unique to individual cattle; however, it requires a great effort to restrain individual cattle to get their nose prints, moreover, the prints cannot be stored nor read swiftly making it inefficient [9].

3. Limitations of classical animal identification methods

This section describes the limitations of individual classical methods of animal identification. Literature has it that brands can be easily damaged or pose difficult reading due to improper application. There is restraint in cattle movement to apply brand on cattle; this also comes with a lot of pains from the burning hot or freezing cold iron. Tagging, such as ear tags also require readings that are visual, and this reading might become illegible with time. Although to place an ear tag on cattle requires minimal strength and restraint with little or no pain if done correctly, the probability of contracting an infection through the method is high.

Ear notching, on the other hand, is an identification method that is widely employed in the herding industry for its fair efficiency but with the problem of easy translation to other livestock identification, moreover, the process is fairly painful, and due to its visual readings method, there might be reading inaccuracies. Tattooing as a common method of permanent cattle identification is painful to apply and might cause infection if not done under good hygienic conditions. Classical nose prints method, otherwise known as muzzle prints, is tasking and not efficient due to the fact that for every comparison, the new print must be taken which requires a great effort that is too slow to accomplish. Many RFID technologies suffer short distance coverage which is not robust for cattle biometrics and monitoring. Biometrics methods of cattle identification have great cattle traceability and information retrieval capability with few drawbacks.

3.1. Petersen nose prints method as an improvement on classical animal identification methods

In October 1921, the use of nose print for cow permanent identification was suggested by O. H. Baker of the America Jersey Cattle Club. More than 350 nose prints of animals were collected and studied. Findings showed that no two animals have the same design. The prints were grouped into different types for the purpose of further studies. The basis for grouping the prints into different types is to know the discriminatory features of the nose textures. Figure 1 shows the representation of the three distinct types that have been worked out.

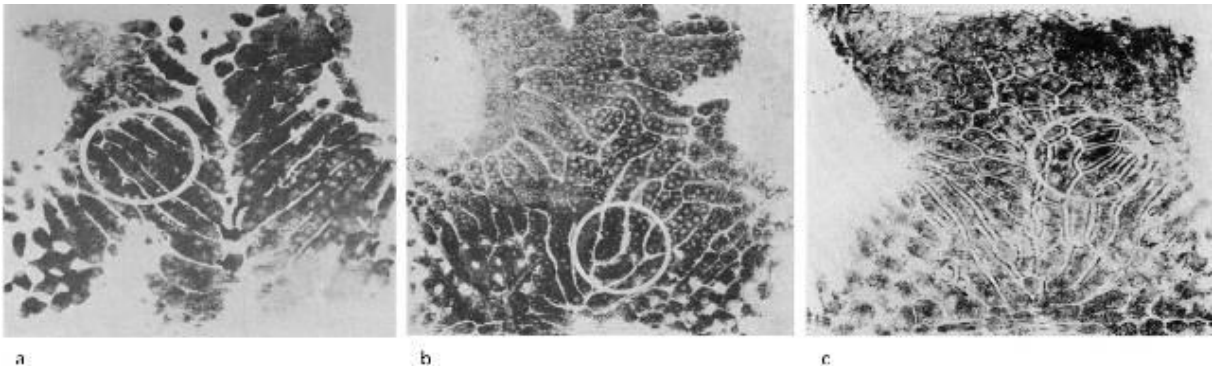

Figure 1. (a) Nose-Print of Jersey Cow Herd No. 124 Owned by University of Minnesota (b) Nose-Print of Jersey Cow Herd No. 113 Owned by University of Minnesota (c) Nose-Print of Jersey Cow Herd No. 107 Owned by University of Minnesota [1].

The method used in capturing the animal nose prints was not scientific although, it was easy and simple. When the animal is in a stanchion, the nose-prints can be manually captured with the help of a man holding the animal head under the arm while the other free hand is used to capture the print. In order for the nose prints not to be affected by the perspiration of the bovine through the nose pores, the nose is wiped dry using a flannel cloth before the application of the ink which is applied immediately using the stamping pad.

The stamping pad is skilfully pressed on or rubbed against the nose then, the print from the stamping pad is captured on the paper attached to a small board by pressing firmly against the inked nose, starting from the paper's lower edge at the base of the upper lip and rolling in the direction of the face. In order for the nose prints not to be affected by the perspiration of the bovine through the nose pores, the nose is wiped dry using a flannel cloth before the application of the ink which is applied immediately using the stamping pad. This enables the ink to flow, up to the brim of the nose's grooves, thereby, produces a smeared print. The hypodermic facial-nasal glands formed the experimental design and therefore giving rise to roughly pronounced elevations that form the irregular lines that resemble grooves between these elevations.

3.1.1. Test with various papers. After a series of tests with various papers, mimeograph news-prints papers gave the best results; this was due to their high absorbing quality. Results from other papers like smooth finish papers produced blurred and smeared prints. Yellow copy paper absorbs the ink satisfactorily but could not produce good photographic work because the pigment of the paper distracts from the perceptible print. In order to allow two prints side by side and create space for data such as cow's name, owner's name, date, an ordinary paper of letterhead size cut into 8½ by 5½ inches sheets was discovered to be the best and convenient size for the experiment. Mimeograph was used for the making of the blanks that were used, printing one set for each nose print to be taken or four on one letterhead size sheet. To handle the print paper conveniently, twelve or more of the above-described blanks are to be attached by means of a clip to a board ¼ inch thick and 8½ inches long by 5½ inches wide. A clean sheet is exposed for the next print after one set of prints has been taken.

3.1.2. Tests with inks. Black stamping pad ink received more acceptance than black printers' ink and mimeograph ink from among the various inks that were used for the experiment. The major reason for rejecting the latter two is the complexity that is involved in getting enough ink into the pad that will be sufficient for all the animals. The tendencies of writing inks to run after applying to the nose make it not suitable for the experiment. Blue printer, red printer, and stamping pad inks did not produce the contrast on the paper and are not good for photographic work as the black ink did.

3.1.3. Petersen's method of prints identification. Prints identification does not involve perfect print for positive identification. That is, for prints to be distinguished from one another, perfection in the print does not necessarily matter. Comparing two prints is one of the methods to ascertain their type. As shown in Figures 2a and 2b, the straight lines coming out from either side of the prints' central and perpendicular line, and upward and outward at about an angle of 45 degrees resulting in very long figures are easily identified as being of the same type. A small, encircled area that belongs to the same region on the two prints is chosen for comprehensive comparison in order to positively identify Figures 2a and 2b as the same prints belonging to the same animal. Coincidental details within the circles as shown in Figures 2a and 2b proved the two prints to be from the same animal. In contrast to Figure 2a as described above, the lower lines of Figure 3a radiate from a central point of the print's base and branch resulting to irregular figures while the top lines are approximately horizontal. Figures 4a and 4b can be identified as another method of identifying the type that a particular print belongs to with the lower lines radiating from a central point of the print's base as in Figures 3a and 3b but do not branch and form rather regular and long figures instead of irregular ones.

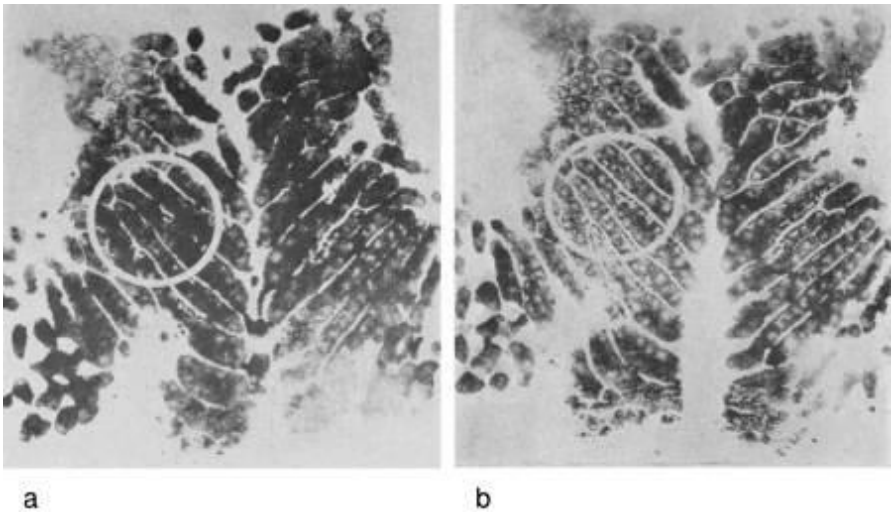

Figure 2. (a) Nose-Print of Jersey Cow Herd No. 124 Owned by University of Minnesota (b) Nose-Print of Jersey Cow Herd No. 124 Owned by University of Minnesota, easily identified as being the same as Figure 2a [1].

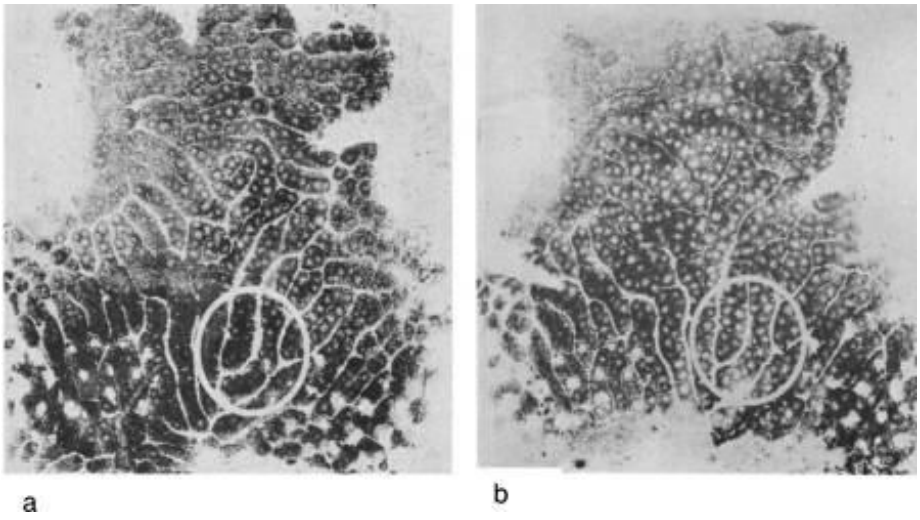

Figure 3. (a) Nose-Print of Jersey Cow Herd No. 113 Owned by University of Minnesota (b) Nose-Print of Jersey Cow Herd No. 113 Owned by University of Minnesota, easily identified as being the same as Figure 3a [1].

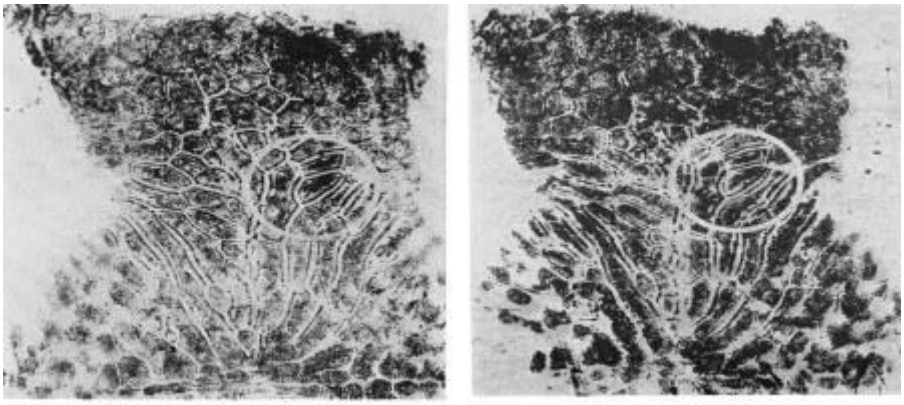

Figure 4. (a) Nose-Print of Jersey Cow Herd No. 107 Owned by University of Minnesota (b) Nose-Print of Jersey Cow Herd No. 107 Owned by University of Minnesota, easily identified as being the same as Figure 4a. These cuts illustrate means of identifying prints. An only a small portion of each print need be taken into consideration as shown by circles [1].

3.1.4. Petersen's experiment on the influence of age on animal's pattern. Nose-print would gradually become practically useless unless the pattern retains its features throughout the animal's life. To ascertain the status of the pattern as the animal increases in age, prints of five calves in the University farm herd were taken at an interval of time for some months (5 months). The calves were seven weeks to twelve months old making the prints taken for this purpose to cover a span of seventeen months. Although there was an enlargement of the nose, no change of the type or pattern of the prints was noticed after a careful study. From the experiment carried out and the observations recorded, over and above from the well-established fact of human finger-print retaining its features throughout the life span, it is acceptable and evidence enough to conclude that the bovine's nose pattern likewise remains unchanged throughout life.

4. State of the art methods

There are different biometric methods of animal identification like body pattern imaging [10], muzzle points extraction [11], facial imaging [12], DNA profiling [9], iris scanning and retinal imaging [9]. Body pattern technique was employed in the work of Zin et al. [13] for the recognition of individual Holstein cattle using a computer vision system which shows great reliability for the cattle identification in natural light. Muzzle point techniques [14-18] were employed to identify individual cattle using deep learning which also shows great recognition accuracy. Facial imaging was employed in the work of Cai and Li [12] with substantial recognition accuracy. Marchant [9] employed a DNA profiling technique in pedigree animal breeding, specifically, cattle, to ascertain their parentage. DNA profiling requires the use of single nucleotide polymorphism (SNP) fingerprint for the recognition of individual animals.

According to Evans and Van Eenennaam [19], there is less than one in a trillion possibilities that two individual animals will in happenstance have identical 30-SNP loci genotypes. Iris scanning technology which has been practically and commercially employed in humans and animals involves a video-based eye image snapshot whereby the iris pattern is extracted and encoded for recognition. Injury and infection are the primary factors that can change or destabilize the unique feature characteristics of the animal iris pattern; this is the reason why it is not advisable to carry out the operation on a young animal until they are several months old [9]. According to Marchant [9], retinal

imaging is a technological method applied on individual animal's unique and unchangeable retinal vascular pattern present in the animal at birth using a hand-held computer with an ocular fundus digital video camera that is linked to a global positioning satellite (GPS) receiver for automatic encryption of details like date, time and place where the retinal was captured [9]. According to Allen et al. [20], these biometrics methods are unique, painless, unalterable, tag-free, and not injurious. Figure 5 shows the cattle recognition system based on the muzzle point image pattern. The system is one of the numerous state of the art systems designed by different animal biometric researchers for cattle recognition and identification using their muzzle point image pattern.

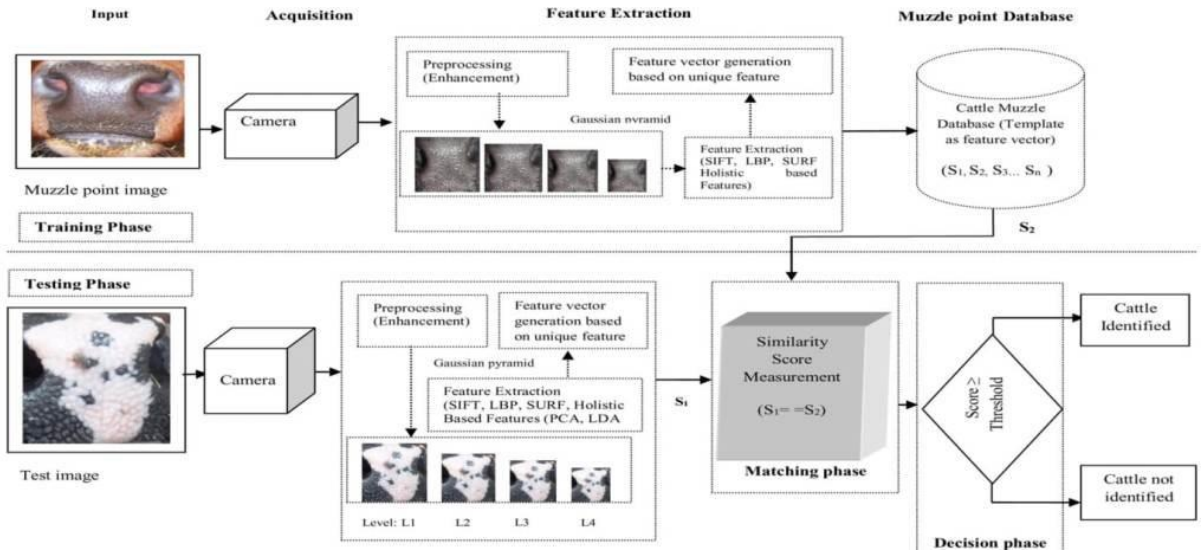

Figure 5. Cattle Recognition System Based on Muzzle Point Image Pattern [16].

5. Discussion and conclusion

This paper has presented a brief history of nose prints for cattle identification. Petersen [1] was the first published paper to address animal biometrics and identification problem by suggesting a permanent cattle identification method based on nose print principles widely accepted today. Before the advent of the nose print method, cattle identification has been by conventional constructs such as tattoo, tags, photographs, descriptions, branding (hot and freeze), ear notching, and sketching (drawings) the color markings on them on paper for registration and identification purposes. These classical methods of identification cause trouble among the breeders especially when their cattle are sold or are on official tests due to lack of artistic ability on the part of the breeders which makes the matching of the sketches and the markings on the animal disagree. Convolutional neural networks and deep learning-based cattle identification applications are proofing that great advancement has been attained in this area of research although with room for improvement.

Among the classical methods reviewed, RFID and biometrics methods performed better with their limitations prompted for the introduction of convolutional neural networks and deep learning in handling livestock identification either in-door or out-door. The in-door monitoring or identification of livestock is not as difficult as monitoring the out-door livestock; reason for the introduction of real-time technology application to handle the tasks. Among the real-time methods found in literature, there is a problem with animal detection and recognition due to the occlusion and non-linear movement of out-door animals; therefore, for animals like cattle to be recognized and identified in real-time, an algorithm that is invariant to occlusion and non-linear movement of the animal is needed irrespective of the similarity in color of the target and the candidate animal.

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